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(54) PROCESS FOR TREATMENT WASTE WATERS

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PROCESS FOR TREATMENT OF WASTE WATERS

ABSTRACT OF THE DISCLOSURE

A process for treating waste waters, e.g. municipal sewage, is described wherein the sewage is treated with lime to a high pH, allowed to settle in a clarifier, and the clarifier effluent at high pH is treated with chlorine. A substantially complete kill of micro-organisms, particularly fecal coliforms and streptococci, is thereby achieved. The effluent, after adjustment to suitable pH, may be returned to natural water streams.

The present invention relates to the treatment and disposal of waste waters, in particular municipal sewage.

BACKGROUND OF THE INVENTION

Many processes have been proposed for the treatment of municipal sewage, and a number of them are in operation. The purpose of such treatment is essentially to separate the solids, whether dissolved or suspended, from the water in which they are carried, so that the residual water, adequately clarified, disinfected and generally rendered harmless to the environment, can be returned to the streams and rivers.

It is known to use lime for the treatment of sewage, usually as one step in a multistep operation. The addition of lime is remarkably effective for the precipitation and the removal of phosphates, which are usually present in abundance in the municipal waste water; it aids in the settling of organic solids, primarily suspended solids; it reduces the COD and BOD of the residual water; and also greatly reduces the number of bacteria and kills viruses and other micro-organisms usually present in waste waters. Lime treatment is sometimes used in primary treatment of sewage, and is then followed e.g. by biological treatment of the residual waters or by treatment with activated carbon. In other cases lime is used in tertiary stage treatment, following conventional primary and secondary stages (Lake Tahoe). It has also been shown that a single stage treatment with lime to a pH about 11 - 11.5 followed by clarification and subsequent pH adjustment, e.g. by carbonation, will not only reduce phosphates to very low levels but will result in a high quality effluent, comparable in quality in respect of most



parameters (and better in respect of some) to effluents obtained after conventional primary and secondary treatment. However, such lime treated effluents may still contain a certain amount of bacteria.

5 It is known to chlorinate waters of various types, in particular the effluent from primary and secondary treatment, to reduce the bacteria content of the water and render it biologically safe. However, when such treated effluents from industrial or municipal waste are treated
10 with chlorine, toxic or otherwise undesirable compounds are formed, e.g. chloramines from the reaction of chlorine with ammonia or chlorinated hydrocarbons as a result of reaction with organic compounds.

BRIEF DESCRIPTION OF THE INVENTION

15 I have found that if waste-water containing bacteria and the like, e.g. raw sewage, is treated with lime to a pH of at least 11.5, and at such pH is treated with chlorine, a substantially complete kill of micro-organisms is achieved in the effluent and
20 the risk of formation of toxic chlorine compounds is substantially reduced.

 Accordingly, the invention provides a process for treating waste-water, particularly municipal sewage, wherein lime is added to the waste-water to form a mixture
25 having a pH of at least 11.5, the mixture is treated to separate from said mixture a sludge containing at least a portion of the solids contained in said mixture and to leave an effluent, said effluent is treated with chlorine until the total residual chlorine (TRC) content of said
30 effluent is at least 0.1 part per million after 15 min.,

and the chlorine-treated effluent is further treated to adjust its pH to an environmentally acceptable level.

THE DRAWING

5 The single Figure of the drawing shows a schematic representation of the process of the invention.

DETAILED DESCRIPTION OF THE INVENTION

10 The treatment with lime is carried out essentially in a known manner, e.g. by continuously introducing a lime slurry at a suitable rate into a continuous stream of raw sewage, or by adding a lime slurry to the sewage in a tank, or in any other suitable manner. Quicklime may be used instead of hydrated lime and it will be understood that the term "lime", as herein used, will denote either the oxide or the hydroxide of calcium, 15 either in dry form or as a slurry. The term sewage, as herein used, will denote any form of municipal or industrial waste-water, which usually contains micro-organisms in addition to the many organic and inorganic waste products carried away in the effluents, e.g. from modern urban agglomerations or some industrial establishments. 20

The lime is thoroughly mixed into the sewage to ensure uniform distribution and to facilitate contact of the lime with the various compounds in the sewage with which it is desired that it shall react. The 25 quantity of lime that has to be added will depend on the type of sewage, the hardness of the water, and so on. For example, in hard water (containing large amounts of bicarbonate) more lime will be required than in "soft water". In any case enough lime will be 30 added to raise the pH of the mixture to at least 11.5.

The mixture is then treated to separate from it a sludge containing at least a portion, but preferably most, of the solids contained in the mixture, and to leave behind a relatively clarified liquid effluent. The separation is conventionally achieved, e.g. by settling in a clarifier, the latter being generally a large vessel maintained in relative quiescence, where the solids are allowed to settle to the bottom, while the supernatant liquid is allowed to overflow. It is preferred, however, prior to passing the mixture to the clarifier, to keep it for a certain time under mild agitation, so as to allow the necessary reactions (such as the formation of various calcium phosphate salts, magnesium hydroxide, etc) to take place, and also to help in the flocculation of the materials, organic and inorganic, which tend to flocculate and agglomerate in the presence of lime and which will subsequently settle out in the clarifier. Thus, as shown in the particular embodiment illustrated in the drawing, the mixture is first introduced into a flocculator and from there passed into the clarifier for settling.

The average residence time of the mixture in clarifier may be several hours. Since it is generally carried out continuously, it is necessary to co-ordinate the inflow of the mixture, the outflow of clarified effluent and the dimensions of the vessel, to allow for the proper settling of the solids, the so-called sludge. The sludge will contain substantially all the solid organic material which has been flocculated and precipitated, as well as subs-

5 tantly all phosphates precipitated in the form of
calcium salts, and also most heavy metal ions, such
as copper, nickel, etc., which may be present particularly
in industrial waste-waters. The precipitation of organic
material will generally result in a reduction of BOD and
COD in the effluent of 50 - 80%, as well as a reduction in
colour, turbidity, etc. This may be sufficient in some cases
for the effluent to be returned to the natural water streams,
but in other cases, where the remaining BOD and COD are
10 still too high to meet existing standards, additional
secondary treatment aimed at further reduction of the
oxygen demanding substances may be necessary. The
sludge containing substantial quantities of calcium
carbonate and calcium hydroxide is essentially odour free
15 and remarkably free of bacteria and may be used
for land fill or for agricultural uses, particularly
on acidic soils. Alternatively, the sludge may be
calcined as a means of disposing of the organic material and
recovering the calcium oxide for reuse in process. Such
20 cyclic operation, however, is economically advantageous
only in large treatment plants.

25 The clarified or supernatant effluent is then
treated with chlorine. By "chlorine" in the present context
is understood chlorine gas or a compound containing reactive
or available chlorine, e.g. hypochlorite, hypochlorous acid,
chlorine dioxide and the like. Preferred use is made of
chlorine gas. The effluent is still at the high pH of at
least 11.5 as a result of the preceding treatment with lime
and this is an important feature of the invention. Chlorine
30 may be introduced directly into the clarifier at a suitable

location for dispersion in the supernatant liquid, but preferably it is added to the effluent after the latter has been removed from the clarifier. Chlorinators which permit controlled introduction of chlorine into a liquid
5 are well known, and the rate and quantity of chlorine allowed to flow can be carefully metered. Sufficient chlorine is added to ensure substantially total destruction of bacteria but the actual quantity of chlorine that is
10 needed for this purpose may be difficult to determine beforehand and, in any case, will vary with various effluents depending on the presence of various substances. For example, the presence of reducing substances, such as organic matter or sulphide, will use up additional chlorine. This is why the common way to ensure that "sufficient"
15 chlorine has been added, is to check for the presence of free chlorine in the water at a certain time after the introduction of the chlorine: if a certain amount of free chlorine remains in the water, it is an indication that sufficient chlorine was added initially.
20 This amount of chlorine remaining in the water and representing the difference between the amount initially applied and that used up by the water, is generally called "total residual chlorine" (TRC). The TRC is usually measured at a certain time, e.g. 15 minutes, after the
25 introduction of chlorine is terminated. Even small quantities of residual chlorine, of the order of 0.1 ppm, are an indication that chlorination has been, by and large, completed. The residual chlorine is measured by a variety of methods, some of which are
30 described in "Standard Methods for the Examination

of Water and Wastewater", (M.C. Rand, A.E. Greenberg
& M.J. Taras, ed., published by American Public
Health Assoc., Washington, D.C., 14 ed., 1976)

As above indicated, the addition of
5 chlorine may be carried out inside the clarifier
itself, or on the effluent removed from the clarifier;
and it will be understood that the term "effluent" as
used herein will apply broadly to the clarified liquid
obtained from the settling of the sludge in a clarified
10 whether partially or fully clarified, and whether remaining
in the clarifier or removed from it. The chlorine-treated
effluent, with a TRC content of at least 0.1 ppm, will
be held for a period of at least one minute before it is
further treated e.g. to reduce the pH of the effluent and
15 bring it closer to environmental requirements. While in
many cases, a TRC of .1 ppm and a residence time of one
minute, will be sufficient to substantially destroy all
micro-organisms, including all fecal coliforms and fecal
streptococci present, in some cases there may be advantage in
20 using higher residual chlorine, and/or a higher residence
time to obtain the desired bactericidal effect. A
preferred TRC range would be between 0.1 and 1.0 ppm.

Treatment with chlorine in the manner
described, notably carrying out the chlorination
25 while the effluent is at a pH at least 11.5, has been
found particularly effective in that the treatment
not only destroys practically completely coliform
bacteria with a relatively low chlorine dose, but
also reduces very markedly the danger of objectionable
30 chlorine compounds being formed, particularly chloramine
or chlorinated hydrocarbons. Even though ammonia is

generally present in the effluent, at this high pH it is weakly ionized and its reaction with the chlorine, which is present as hypochlorite, will be very slow. Similarly, hydrocarbon reactions with chlorine will be relatively slow at such high pH.

In most cases where the chlorinated effluent is to be returned to natural water, it is further treated to reduce its pH to a level suitable for the environment. This can be achieved by treatment with any suitable acid. A convenient treatment is by means of CO_2 , as this will produce a precipitate of CaCO_3 , relatively pure and easily settleable, which can be recovered, e.g. by settling in secondary clarifier, for a variety of possible uses. But the effluent from the secondary clarifier would still be at a relatively high pH, usually about 9 - 9.5, and a final adjustment of the pH to a lower value may be desirable if the water is to be released into a natural stream. The final pH adjustment may be to a value of about 7-7.5 or higher, depending on the pH of the environmental streams to which the thus "neutralized" effluent is being added. Since it is a matter of choice dictated largely by environmental conditions, this final pH will be termed herein one of "an environmentally acceptable level".

In the particular embodiment of the invention shown diagrammatically in the drawing, raw sewage is continuously fed to a mixing tank where it is mixed with a lime slurry. The slurry is prepared, e.g. in a slurry tank, and fed to the mixing tank in appropriate quantity or at an appropriate rate, to bring the pH of the mixture to at least 11.5. Suitable mixing means are provided, both

for the preparation of the slurry and for the mixing of the lime slurry with the sewage. The sewage-lime mixture is then passed into a flocculator where the major reactions of the lime with organic and inorganic substances take place and where the suspended or freshly precipitated solids agglomerate into larger particles that will have a greater tendency to settle. The mixture is then passed into a primary clarifier where the solids settle by gravity, forming a sludge.

The liquid effluent flowing out of the primary clarifier is then treated with chlorine as hereinabove described. While the addition of chlorine is represented in the Figure as a step following the settling in the primary clarifier, this being the preferred procedure, it will be understood that both steps can also be carried out simultaneously, e.g. when chlorination is carried out in the liquid in the clarifier itself. The sludge is removed and later disposed of in a suitable manner.

The chlorinated effluent is then passed into a carbonation unit where carbon dioxide is introduced into the liquid and reacts with the lime remaining in the liquid to form calcium carbonate. The carbonate is allowed to settle in a secondary clarifier and the now substantially clear liquid is further carbonated, or treated with sulfuric acid or with any other suitable acid, to adjust the pH as explained above, e.g. by bringing it substantially close to neutrality. The clarified and neutralized water is now ready to be returned to a stream or river or otherwise utilized for whatever purpose may be indicated.

The following Examples further illustrate the invention, it being understood that neither these examples nor the above drawing are to be interpreted as in any way limiting the scope of the invention.

5 Examples I - III

In a series of laboratory tests sewage was treated in accordance with the invention, namely: the raw sewage was treated with lime to a pH of 11.5, and allowed to settle, and the effluent, separated from the sludge, was treated with chlorine to a residual chlorine level respectively of 0.1 mg/l (treatment A), 0.5 mg/l (treatment B) and 1.0 mg/l (treatment C). The chlorine-treated effluent was held at the unchanged pH level of 11.5 for about one minute, then carbonated to a pH 9.3 and finally adjusted to a pH of approximately 7 and held at this pH for varying lengths of time, viz. 1, 10 and 30 minutes. Samples for bacteria counts were taken at the end of these 1, 10 and 30 minutes respectively. For comparison, the same raw sewage without the preliminary lime treatment (i.e. essentially at neutral pH), was allowed to settle and the effluent was chlorinated to the same residual chlorine level and held for 1 minute, after which a bacteria count was taken. In another comparison, the same sewage was treated with lime to a pH 11.5, and allowed to settle, without subsequent chlorination of the effluent, and a bacteria count of the effluent was taken after one minute. The raw sewage (which was the same in all experiments) had an average bacteria count per ml. as follows:

	Total bacteria	2.9×10^5
30	Total coliforms	1.4×10^5
	Fecal coliforms	1.3×10^4
	Fecal streptococci	8.0×10^2

The resulting bacteria counts are shown in Table I.

TABLE I

I.	<u>Treatment A*</u>		<u>Chlorination</u> <u>only**</u>		<u>Lime</u> <u>only***</u>	
	1 min.	10 min.	30 min.			
5	Total bacteria	3.5×10^0	1.0×10^0	nil	1.7×10^5	2.1×10^4
	Total coliforms	nil	nil	nil	6.1×10^4	1.2×10^2
	Fecal coliforms	nil	nil	nil	3.1×10^3	4.0×10^1
10	Fecal streptococci	nil	nil	nil	4.0×10^1	2.2×10^2

- 15 * Treatment A: Effluent at pH 11.5 coming out of primary clarifier, chlorinated to a level to give a total residue of chlorine (TRC after 15 min) of 0.1 mg/l; maintained at these conditions for 1 minute; then pH lowered to 9.3 and kept at this pH for 30 minutes; then pH further lowered to 7.0 and kept at pH further lowered to 7.0 and kept at
- 20 this pH for varying lengths of time, i.e. 1, 10 and 30 minutes. Samples for bacteria counts were taken at the 1, 10 and 30 minutes.
- 25 ** Chlorination only Primary effluent chlorinated to TRC 0.1 mg/l without prior lime treatment.
- *** Lime only: Raw sewage treated with lime to pH 11.5 without subsequent chlorination.

II.		1 min.	Treatment B*		Chlorination only**
			10 min.	30 min.	
	Total bacteria	9.5×10^0	5.0×10^0	6.0×10^0	1.5×10^5
5	Total coliforms	nil	nil	nil	1.2×10^2
	Fecal coliforms	nil	nil	nil	4.0×10^1
10	Fecal streptococci	nil	nil	nil	2.2×10^2

* Treatment B: Same as Treatment A except that chlorination was to 0.5 mg/l total residual chlorine

** Chlorination: Primary effluent chlorinated to TRC 0.5/mg/l
15 only without prior lime treatment.

III.		1 min.	Treatment C*		Chlorination only**
			10 min.	30 min.	
20	Total bacteria	4.5×10^0	3.0×10^0	3.5×10^0	7.7×10^4
	Total coliforms	nil	nil	nil	1.2×10^2
	Fecal coliforms	nil	nil	nil	4.0×10^1
25	Fecal streptococci	nil	nil	nil	2.2×10^2

* Treatment C: Same as A, except that chlorination was to 1.0 mg/l TRC.

** Chlorine: Primary effluent chlorinated to 1.0 mg/l
30 only TRC without prior lime treatment.

Examples IV - VI

The procedure according to the invention was followed, substantially as in the preceding Examples, except that the chlorination of the lime treated sewage was carried out in the primary clarifier and not, as in previous examples, on the effluent removed from the clarifier. The effluent at a pH of 11.5 was chlorinated to residual chlorine levels of 0.1 mg/l (treatment A), 0.5 mg/l (treatment B) and 1.0 mg/l (treatment C), respectively, and the chlorinated sewage was held at the unchanged pH level of 11.5 for about 10 minutes, then carbonated and held at a pH of 9.3 for 30 minutes, and finally adjusted to pH 7 approximately and held at this pH respectively for 1, 10 and 30 minutes. As in previous examples comparisons were made with the treatment of the same sewage by only chlorinating to the same residual chlorine level (without preliminary lime treatment) and by only treating with lime (without chlorination). Samples were analyzed for bacteria content as before. The bacteria count is shown in Table II.

TABLE II

I.	1 min.	<u>Treatment A</u>		<u>Chlorination only</u>	<u>Lime only</u>
		10 min.	30 min.		
5	Total bacteria	6.5×10^1	2.1×10^1	3.5×10^0	9.1×10^4
	Total coliforms	1.0×10^0	1.0×10^0	nil	1.6×10^4
	Fecal coliforms	nil	nil	nil	2.6×10^2
10	Fecal streptococci	6.5×10^0	nil	nil	3.5×10^0
					1.2×10^1
II		<u>Treatment B</u>		<u>Chlorination only</u>	
		10 min.	30 min.		
	Total bacteria	3.5×10^2	1.3×10^1	$13. \times 10$	7.8×10^4
15	Total coliforms	3.5×10^1	nil	nil	7.0×10^3
	Fecal coliforms	2.5×10	nil	nil	1.7×10^2
20	Fecal streptococci	9.5×10^0	nil	nil	nil
III.		<u>Treatment C</u>		<u>Chlorination only</u>	
		10 min.	30 min.		
	Total bacteria	2.9×10^1	9.0×10^1	8.0×10	2.8×10^3
25	Total coliforms	nil	nil	nil	1.4×10^2
	Fecal coliforms	nil	nil	nil	nil
	Fecal streptococci	nil	nil	nil	nil

30 Examples VII - IX

The procedure of Examples IV - VI was used except that the lime-treated and chlorinated sewage was held after chlorination (and prior to carbonation) for 30 minutes. The bacteria count is shown in Table III.

TABLE III

I.		<u>Treatment A</u>		
		1 min.	10 min.	30 min.
5	Total bacteria	1.7×10^1	8.0×10^0	4.0×10^0
	Total coliforms	0.5×10^0	nil	nil
	Fecal coliforms	nil	nil	nil
10	Fecal streptococci	nil	nil	nil
II.		<u>Treatment B</u>		
	Total bacteria	1.1×10^2	$14. \times 10^1$	4.0×10^0
15	Total coliforms	0.5×10^0	nil	nil
	Fecal coliforms	nil	nil	nil
20	Fecal streptococci	4.0×10^0	nil	nil
III.		<u>Treatment C</u>		
	Total bacteria	2.1×10^1	8.5×10^0	8.5×10^0
25	Total coliforms	nil	nil	nil
	Fecal coliforms	nil	nil	nil
	Fecal streptococci	nil	nil	nil
30	<u>Examples X - XII</u>			

The procedure of Examples IV - VI was followed except that the lime-treated and chlorinated sewage was held after chlorination (and prior to carbonation) for 120 minutes. The bacteria count is shown in Table IV.

TABLE IV

I.		<u>Treatment A</u>		
10	Total bacteria	9.5×10^0	8.5×10^0	3.5×10^0
	Total coliforms	nil	nil	nil
	Fecal coliforms	nil	nil	nil
	Fecal streptococci	nil	nil	nil
II.		<u>Treatment B</u>		
20	Total bacteria	6.5×10^0	1.3×10^1	6.0×10^0
	Total coliforms	nil	nil	nil
	Fecal coliforms	nil	nil	nil
	Fecal streptococci	nil	nil	nil
III.		<u>Treatment C</u>		
20	Total bacteria	1.7×10^1	7.0×10^0	6.0×10^0
	Total coliforms	nil	nil	nil
	Fecal coliforms	nil	nil	nil
	Fecal streptococci	nil	nil	nil

SUPPLEMENTARY DISCLOSURE

The principal disclosure provides a novel process for the treatment of municipal or industrial wastewater. This procedure has been found to be satisfactory in the removal of coliforms from municipal and/or industrial wastewater while minimizing the risk of formation of toxic chlorine compounds. It has additionally been found that the results of the above procedure may be substantially obtained by carrying out the steps comprising mixing with said wastewater, a material containing a compound chosen from the group consisting of calcium oxide and calcium hydroxide thereby to form a mixture having a pH of at least about 11.0, the mixture containing solids in suspension in a liquid, treating the mixture to separate at least a portion of the solids from the liquid, treating the liquid at the pH of at least about 11.0 with chlorine until the TRC is at least 0.1 parts per million.

It has been found that the treatment with chlorine is particularly effective at wastewater pH's of about 11.0 and above. The treatment results in a substantial reduction in the coliform content of the wastewater and it has been found that the results of chlorination at a pH of about 11.0 are substantially equivalent for most wastewater effluents to those obtained with the process employing a pH of about 11.5 as described in the principal disclosure.

The addition of lime, separation of solids and chlorination are carried out in essentially the same fashion as described in the principal disclosure. A reduction of the pH of the chlorinated wastewater may be necessary, depending on the pH of the receiving environmental stream. In some cases however, where the receiving body of water has a pH lower than 7, due to phenomena such as "acid rain" or the like, it may be desirable to discharge the clarified wastewater at a pH higher than 7, and in some of these cases, decreasing the pH following the first clarification stage may not be necessary.

EXAMPLE XIV

This example illustrates the effect of lime treatment and chlorination of the sewage at pH's of 11.0 and 11.5 according to the present invention.

The pH of raw sewage was initially adjusted to 11.0 by the addition of lime, at which pH it was held for an hour, following which it was chlorinated to a TRC of 0.2 mg/l and the pH reduced to 9.5 by passing carbon dioxide through the sample. The total bacteria count (TPC), total coliform count (TC) and fecal coliform count were taken. These are tabulated in Table V below.

This procedure was repeated with an initial pH of 11.5. It was found that pH's of 11.0 and 11.5 were equivalent in their disinfectant ability for this particular sewage sample.

TABLE V

PARAMETER (Counts) MEASURED (100 ml.)	RAW SEWAGE	INITIAL pH ON LIMING THE SEWAGE	
		<u>11.0</u>	<u>11.5</u>
1. Total Plate Count (TPC)	3×10^{10}	3.3×10^4	4.8×10^4
2. Total Coliform (TC)	9.3×10^7	1.1×10^0	1.1×10^0
3. Fecal Coliform	3×10^6	0	0

10

The description and example provided above are for the purpose of providing a complete disclosure of the invention, and alterations and modifications thereof may occur to those skilled in the art. Therefore, I do not wish to be limited to the embodiments described above, but only by the scope of the appended claims.

The embodiments of the invention in which an exclusive property of privilege is claimed is defined as follows:

1. A process for treating municipal or industrial wastewater containing microorganisms which comprises the steps of:

- (a) mixing said wastewater with a material containing a compound of the group consisting of calcium oxide and calcium hydroxide thereby to form a mixture having a pH of at least about 11.5, said mixture containing solids in suspension in a liquid,
- (b) treating said mixture to separate at least a portion of said solids from said liquid,
- (c) treating said liquid at said pH of 11.5, with chlorine in an amount to provide a total residual chlorine content (TRC), of at least about 0.1 parts per million in said liquid, and
- (d) adjusting the pH of said chlorine-treated liquid to an environmentally acceptable level.

2. The process of claim 1 wherein said mixture is treated to separate said solids from said liquid by

passing said mixture into a clarifier and allowing solids to settle out of suspension in said clarifier.

3. Process of claim 1 where said liquid is treated with chlorine in an amount such that said total residual chlorine content (TRC) is 0.1 to 1.0 parts per million in said liquid.

4. The process of claim 1 wherein said chlorine is chlorine gas.

5. The process of claim 1 wherein said chlorine-treated liquid is held prior to said adjustment of pH for at least one minute.

6. The process of claim 1 wherein said chlorine-treated liquid is contacted with carbon dioxide until the pH of said liquid is about 9 - 9.5 before said adjustment of pH of said liquid to an environmentally acceptable level.

7. A continuous process for treating municipal or industrial wastewater containing micro-organisms and recovering a purified and disinfected liquid there-from comprising:

- (a) continuously passing said wastewater to a mixing zone,
- (b) adding a material containing a compound of the group consisting of calcium oxide and calcium hydroxide to said mixing zone,

(c) forming in said zone an intimate mixture of said wastewater and said material, said mixture having a pH of at least 11.5 and containing solids suspended therein,

(d) passing said mixture to a clarification zone,

(e) separating said mixture in said clarification zone into a sludge containing at least a portion of said solids and a supernatant liquid, said liquid having a pH of at least 11.5,

(f) treating said liquid at a pH of at least 11.5 with chlorine in an amount to provide a total residual chlorine content (TRC) of at least about 0.1 parts per million in said liquid,

(g) passing said chlorine-treated liquid to a pH adjustment zone, and

(h) adjusting the pH of said liquid to an environmentally acceptable level.

8. The process of claim 7 wherein said material is a lime slurry.

9. The process of claim 7 wherein said liquid is passed from said clarification zone to a chlorination zone and said treatment of said liquid with chlorine is carried out in said chlorination zone.

10. The process of claim 7 wherein said liquid from said pH adjustment is released into the environment.

CLAIM SUPPORTED BY SUPPLEMENTARY DISCLOSURE

11. A process of treating municipal or industrial wastewater containing microorganisms which comprises the steps of:

(a) mixing said wastewater with a material containing a compound of the group consisting of calcium oxide and calcium hydroxide thereby to form a mixture having a pH of at least about 11.0, said mixture containing solids in suspension in a liquid,

(b) treating said mixture to separate at least a portion of said solids from said liquid,

(c) treating said liquid at said pH of at least about 11.0, with chlorine until the total residual chlorine content (TRC) of said liquid is at least 0.1 parts per million.

12. The process of claim 11, wherein said pH is at least about 11.5

13. The process of claim 11, where the pH of said chlorine-treated liquid is adjusted to an environmentally acceptable level.

14. The process of claim 13, where said reduction of the pH of said chlorine-treated liquid comprises, in a

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first step, contacting said chlorine-treated liquid with carbon dioxide until the pH of said chlorine-treated liquid is about 9 to 9.5 and, in a second step, adjusting the pH of said chlorine-treated liquid to an environmentally acceptable level.



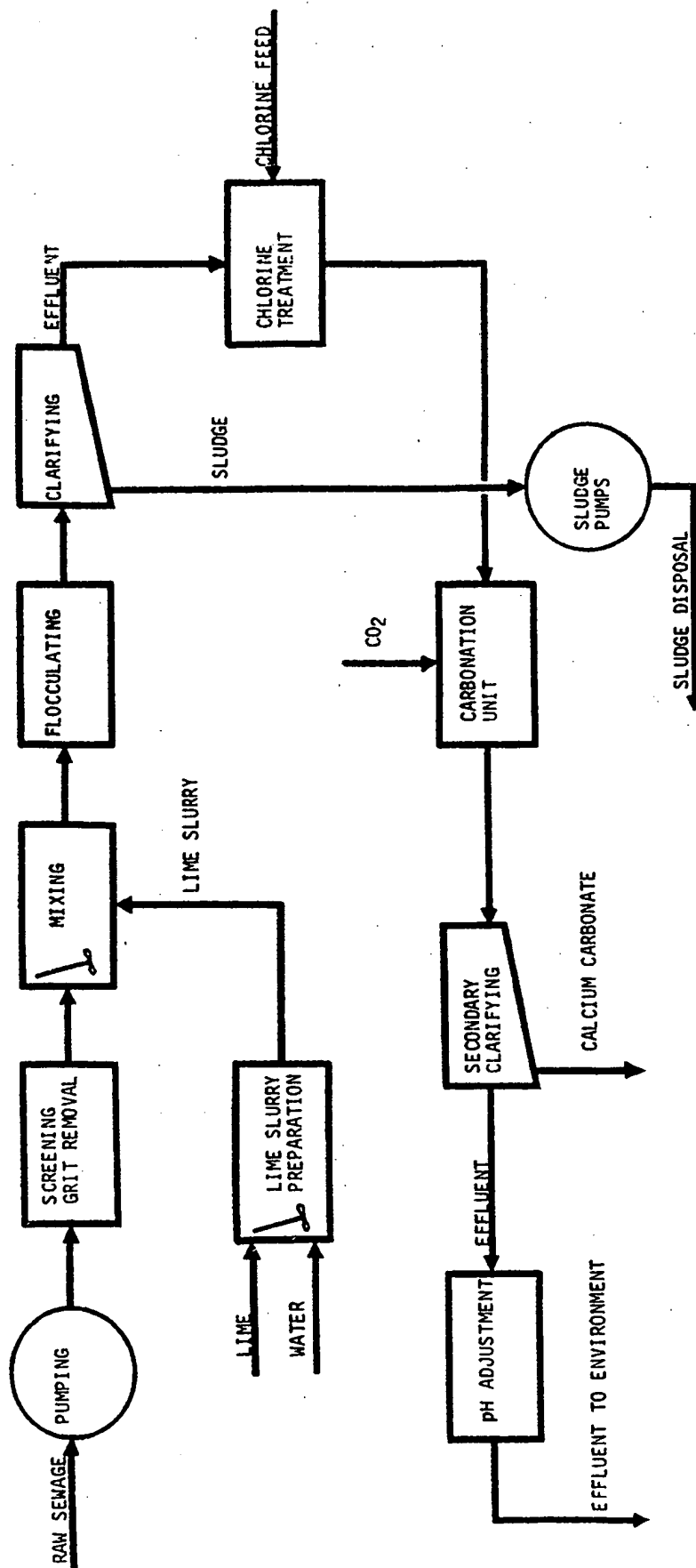


FIGURE 1